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PUUKOHOLA HEIAU NATIONAL HISTORIC SITE

MARINE FLORA

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(Final Report)

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The National Park Service and the University of Hawaii signed the memorandum of agreement establishing this Cooperative National Park Resources Studies Unit (CPSU UH) on March 16, 1973. The CPSU UH provides a multidisciplinary approach to studies on the biological resources in the National Parks in Hawaii, that is, Hawaii Volcanoes National Park, Haleakala National Park, City of Refuge National Historical Park, and Puukohola Heiau National Historic Site. Through the Unit Director, projects are undertaken in areas identified by park management. These studies provide information for resource management programs. The involvement of University faculty and students in the resource management of the National Parks in Hawaii leads to a greater awareness of the problems and needs of the National Park Service. At the same time, research not directly or immediately applicable to management is also encouraged through the CPSU UH.

Contribution numbers are assigned as follows. CPSU UH identifies the Cooperative National Park Resources Studies Unit of the University of Hawaii. This is followed by a three-digit number assigned in sequence to each new project of this CPSU. The fourth digit indicates the report number for that particular project.

BENTHIC MARINE ALGAE OF THE COASTAL WATERS
OF PUUKOHOLA HEIAU NATIONAL HISTORIC SITE

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ABSTRACT

The intertidal, coral, and sandy-bottom areas near the shoreline of Puukohola Heiau National Historic Site were surveyed for macroscopic benthic algae. There were only 13 species present, of which only 2 were abundant, *Biddulphia pulchella* and *Valonia aegagrophila*. Two species which are sometimes indicators of polluted water, *Ulva fasciata* and *Enteromorpha* sp., were present along the Kawaihae revetment. The flora is depauperate: the low species diversity and biomass is the result of extensive sedimentation from runoff and the building of the Kawaihae revetment. Since the area is no longer flushed out by the tides or currents, the present status of the benthic algae will probably remain the same.

TABLE OF CONTENTS

Abstract	i
Introduction	1
Description of Study Area	1
Methods and Materials	3
Results	5
Discussion	5
Recommendations	10
Literature Cited	11
Acknowledgements	11
Appendix	12

LIST OF TABLES AND FIGURES

Table I. Checklist of benthic marine algae	6
Table II. Relative abundance of benthic marine algae	7
Figure 1. Map showing location of Puukohola Heiau National Historic Site	2
Figure 2. Pattern used for marine algal survey	4

INTRODUCTION

Pu'ukoholā Heiau and its immediate environs comprise the recently established National Historic Site administered by the National Park Service. The purpose of this survey, which took place April 10-13, 1976, was to inventory the macroscopic marine algal flora associated with the Historic Site. The investigation is to provide information that will facilitate the development and implementation of resource management programs.

DESCRIPTION OF STUDY AREA

The Puukohola Heiau National Historic Site (PUHE) is located on the northwest coast of the Island of Hawai'i. The area is flanked by Kawaihae Boat Harbor to the north and Spencer Beach Park to the south (Figure 1). The Historic Site is bordered on the west by the ocean; the immediate marine area is a small, shallow embayment. The proposed boundaries of the offshore segment of the Historic Site encompass an area of approximately 45,000 square meters (11.1 acre). Within this area near the mouth of Makeāhua Gulch is the probable location of a shark heiau, Hale o Kapuni.

An estimated 80 percent of the natural reef was destroyed within the embayment and adjacent areas by blasting and dredging activities during construction of the Kawaihae Boat Harbor in 1969-70 (U.S. Army Corps of Engineers 1975). Sand channels and reef debris now dominate the area although an occasional live coral head can be observed, especially in the

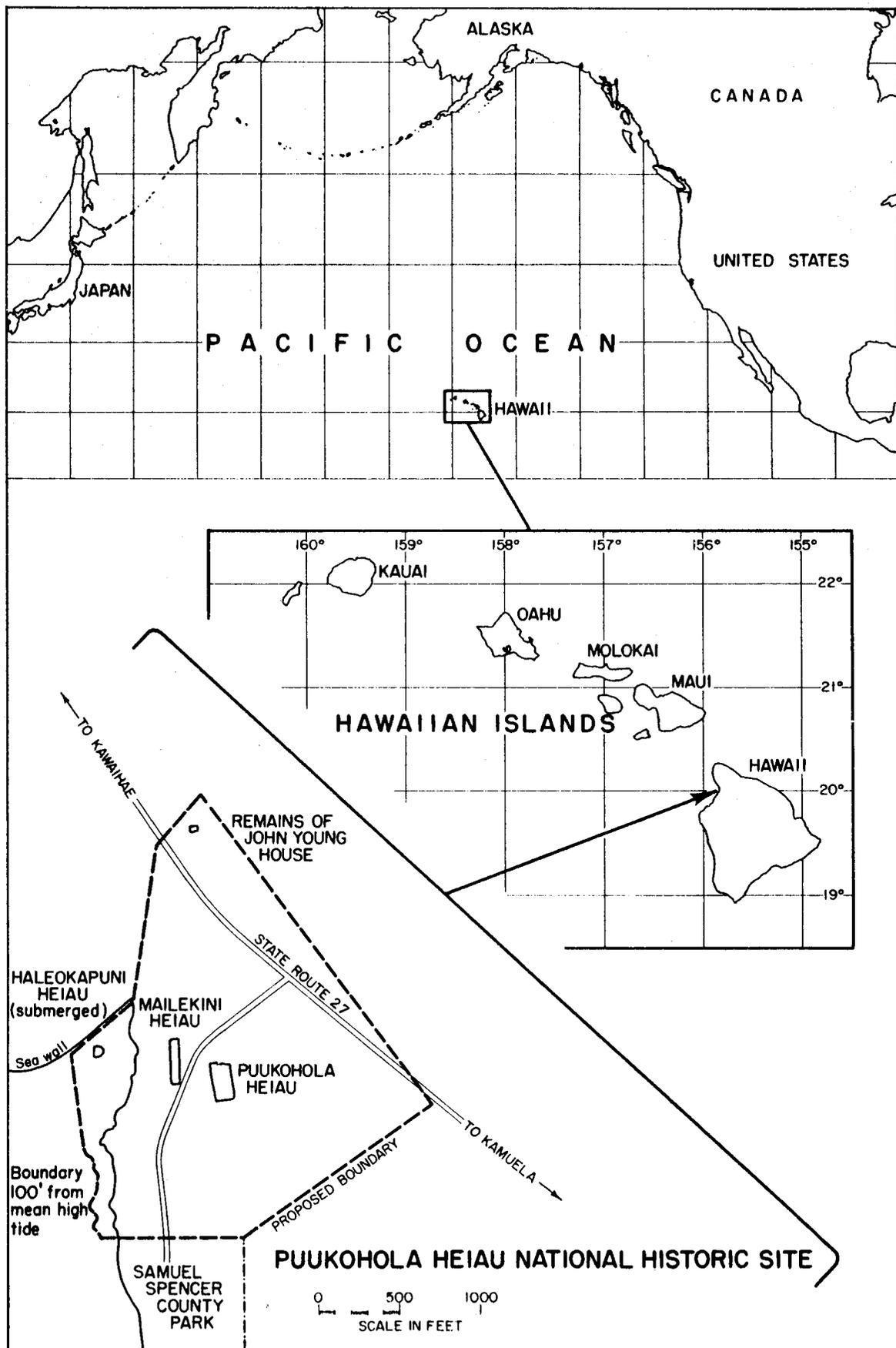


Figure 1. Map showing the location of the Puukohola Heiau National Historic Site on the Island of Hawaii.

seaward portion of the embayment. Perhaps half of the area is silted over by alluvium, deposited in part by local runoff. Water turnover deep within the embayment appeared to be slight, due to its being shallow and somewhat sheltered from the prevailing northeast trades, and also because the Kawaihae Harbor revetment has blocked the current which used to sweep this part of Kawaihae Bay. Although some flushing action no doubt occurs during tidal exchanges, it evidently is not adequate to purge the bottom of its silty deposits. As a consequence of the silty substratum, fine sediments in suspension reduce visibility to a mere few centimeters in some parts of the embayment. Subsurface visibility is further complicated by the presence of freshwater lenses, in particular just off the southeastern shoreline. Except for a small stretch of sandy beach, most of the Historic Site's limited coastline consists of a slightly elevated rock bench. Hydrological and physiographical features of the study area (Cheney et al. 1977) are listed in the Appendix.

METHODS AND MATERIALS

The study area was surveyed by snorkeling in a methodical pattern (Figure 2). Observations and collections were also made along the shoreline. Location and species of seaweed observed were noted and collections were made.

A reference collection of the marine algae collected will be deposited at the Puukohola Heiau National Historic Site and at the Bishop Museum.

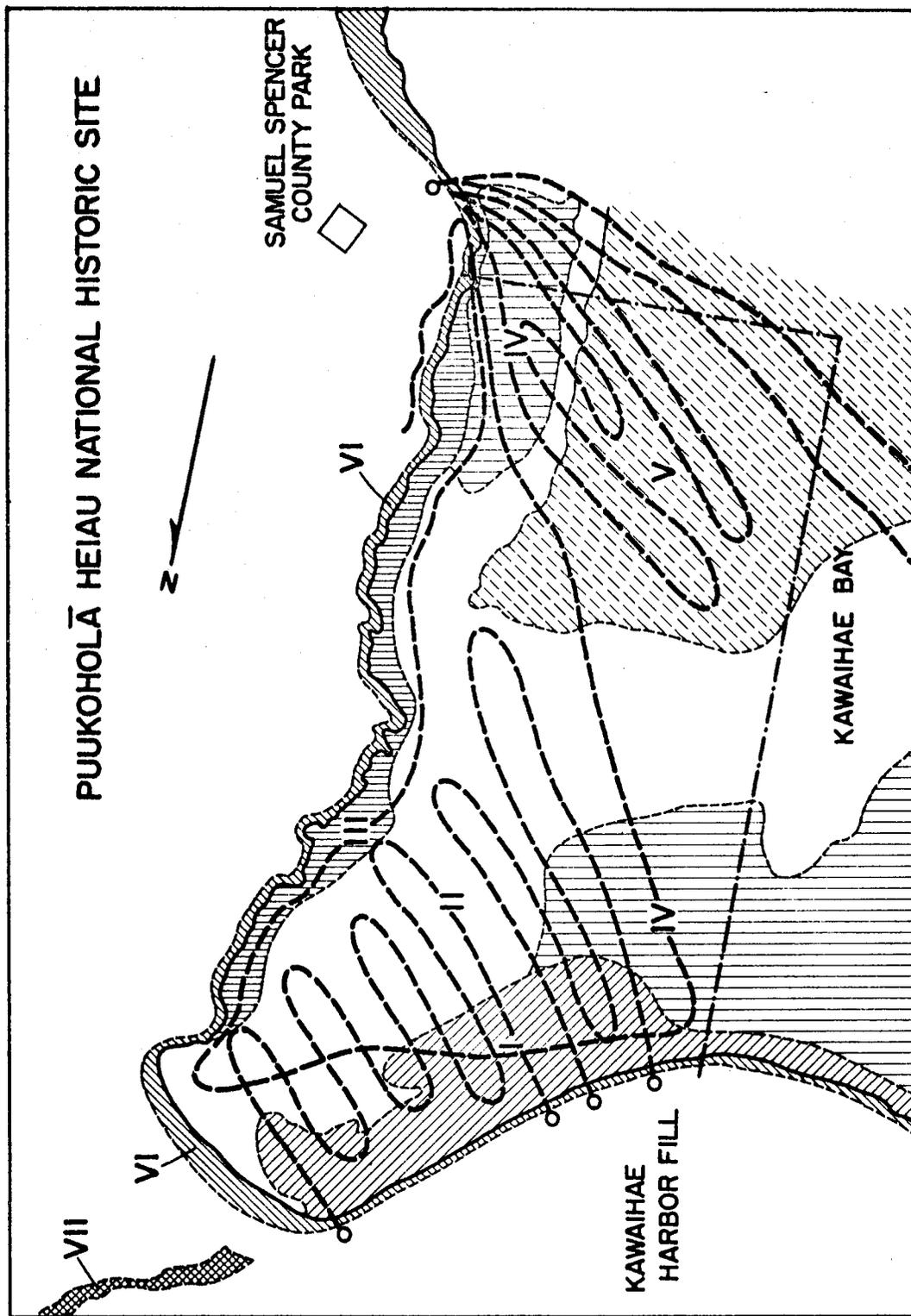


Figure 2. Pattern used for marine algal survey at Puukohola Heiau National Historic Site. Roman numerals indicate biotopes listed in Appendix.

RESULTS

All told, 13 species of benthic algae were collected: 7 species from the phylum Rhodophyta, 5 from the phylum Chlorophyta, and 1 from the phylum Chrysophyta. Table I provides a checklist of species with their status, i.e., whether endemic, indigenous, or exotic. Table II lists their relative abundance and habitats.

DISCUSSION

Algal diversity and density along the rocky edges of the shore were conspicuously low compared to adjacent areas beyond the proposed boundaries of Puukohola Heiau National Historic Site. Four species of algae collected in this area were *Ulva fasciata*, *Valonia aegagrophila*, *Dictyosphaeria versluysii*, and *Ahnfeltia concinna*. The low density of algae in this area is probably the result of heavy shading from the kiawe trees which overhang the shoreline. The *Ahnfeltia* was an atypical morphological form which may have been due to shading.

Offshore, from the mouth of the embayment out to about 100 m (110 yards), extensive colonies of the diatom *Biddulphia pulchella* were observed amidst the silt and debris, interspersed on occasion with *Enteromorpha* sp., *Ulva fasciata*, *Polysiphonia mollis*, *Grateloupia filicina*, and *Acanthophora spicifera*.

Further seaward, large mounds of coral rubble were encountered along with isolated live coral heads. In many instances, the coral rubble was covered by moderate growths

TABLE I

CHECKLIST OF BENTHIC MARINE ALGAE AT
PUUKOHOLA HEIAU NATIONAL HISTORIC SITE

Scientific Name	Common Name	Status
CHRYSOPHYTA		
<i>Biddulphia pulchella</i> Gray	. . .	I
CHLOROPHYTA		
<i>Cladophora</i> sp.	hulu-'īlio	I
<i>Enteromorpha</i>	'ele'ele	I?
<i>Valonia aegagrophila</i> C. Ag.	līpu'upu'u	I
<i>Ulva fasciata</i> Delile	pahapaha	I
<i>Dictyosphaeria versluysii</i> Weber van Bosse	līpu'upu'u	I
RHODOPHYTA		
<i>Acanthophora spicifera</i> (Vahl) Boerg.	. . .	X
<i>Ahnfeltia concinna</i> Ag.	'aki'aki	I
<i>Grateloupia filicina</i> (Wulfen) C. Ag.	huluhulu-waena	I
<i>Polysiphonia mollis</i> Hook & Harv.	hāwane	I
<i>Amansia glomerata</i> C. Ag.	līpepeiao	I
<i>Tolypiocladia</i> sp.	. . .	I
<i>Porolithon onkodes</i> (Heydrick) Foslie	. . .	I

NOTE: Status: I = Indigenous, X = Exotic.

TABLE II. RELATIVE ABUNDANCE OF BENTHIC MARINE ALGAE AT
PUUKOHOLA HEIAU NATIONAL HISTORIC SITE.

Habitat	Species	Relative Abundance*
<u>Subtidal</u>		
Coral heads; depth 3-7 m	<i>Tolypiocladia</i>	moderate
Coral rubble scattered among sediments; depth 0.3-1 m	<i>Cladophora</i> sp.	moderate
	<i>Ulva fasciata</i>	moderate
	<i>Enteromorpha</i> sp.	moderate
	<i>Grateloupia filicina</i>	infrequent
	<i>Polysiphonia mollis</i>	moderate
	<i>Acanthophora spicifera</i>	moderate
Forming widespread mats atop bottom sediments (epipelagic); 0.3-1 m	<i>Biddulphia pulchella</i>	abundant
Margins of inshore bench from sublittoral fringe to 0.5 m	<i>Amansia glomerata</i>	infrequent
<u>Intertidal</u>		
Narrow rock bench sloped slightly seaward with a few pockets of trapped seawater	<i>Ulva fasciata</i>	infrequent
	<i>Valonia aegagrophila</i>	abundant
	<i>Dictyosphaeria versluysii</i>	infrequent
	<i>Ahnfeltia concinna</i>	moderate

*Infrequent = less than 20% coverage per square meter;
 Moderate = 20-60% coverage per square meter;
 Abundant = greater than 60% coverage per square meter.

of the crustose red alga, *Porolithon onkodes*. The live coral heads were relatively clear of macroscopic benthic algae. This result is not unexpected; healthy coral heads are rarely covered by macroscopic algae. However, in certain areas the red filamentous algae, *Tolyptocladia* sp., was relatively abundant on coral heads in crevices and patches adjacent to the living coral.

Of the total biomass of algae observed, the diatom *Biddulphia pulchella* appeared to be present in the largest quantity. The abundance of this species is unusual compared with my previous observations. It may be that its abundance is due to the large quantity of organic and inorganic matter in suspension, and hence increased nutrient loading of the water mass.

A detailed examination of some of the environmental factors that may account for the relatively low density and diversity of the marine macrophytic algae points to turbidity as being the most important. A direct result of turbidity is the reduction of light penetrating below the surface, due to the absorption and reflection of light rays by suspended matter. Although there are differences in the need for light among various species of algae, a marked reduction of light will affect plant assimilation to the point that the species can no longer survive.

Deposition rate is also an important environmental factor affecting algae. If sediments and other kinds of suspended matter precipitate rather rapidly and there is

insufficient water movement to purge the bottom of this loose material, then the chances of algal spores surviving being smothered are poor.

The nature of substratum is also important. Most macrophytic algae tend to favor those areas that have a substantially stable surface to grow upon. Bottom materials consisting of sand, mud, cobblestone, and the like are usually too mobile to provide an adequate surface for algal spores to settle upon and survive, primarily because of the resultant scouring, grating, or smothering action that is characteristic of these types of substrata.

Lastly, lack of sufficient water movement can also pose problems for algae, as well as for other kinds of organisms, in that such factors as water temperature, salinity, removal of metabolic waste materials, and the addition of nutrients to a given area largely depend on water mixing processes. To what extent this factor affects the area surveyed was not determined, but the problem does exist there.

In conclusion, turbidity and silt deposition are the primary limiting factors accounting for the paucity of macrophytic algae at the Puukohola Heiau National Historic Site.

RECOMMENDATIONS

No recommendations for management of the macroscopic benthic algae are offered. No rare or unusual species are present.

Deterioration of the present environment should be prevented. Any future construction along the Kawaihae revetment should be opposed if it will reduce water currents in the bay. Further stagnation in the waters of the embayment adjacent to Puukohola Heiau National Historic Site could result in (1) obnoxious odors and an unsightly area, as well as (2) sharks and other animals avoiding the area.

Development along Makeāhua Gulch which will result in increased erosion should be opposed.

LITERATURE CITED

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APPENDIX

Physical characteristics of the marine biotopes within the Pu'ukoholā survey area. Visibility is defined as low (0.2 to 1 m), medium (1 to 2 m) or high (2 to 6 m). Depth is the approximate range in meters at mean low water.

Biotope Number	Biotope	Temperature (°C)	Salinity (‰)	Visibility	Water Depth (m)
I	Mixed rubble and silt bottom	29.5	31.4	Low	0.1 to 1
II	Sand and silt bottom	24.0	32.5	Medium	1 to 5
III	Basalt pavement with rubble	25.5	25.7	Medium	0.1 to 2
IV	Coral in mixed rubble	24.0	32.5	Medium to high	1 to 5
V	Patch reefs	24.0	32.5	High	0.1 to 5
VI	Intertidal	25.0 to 28.5	3.0 to 25.0	Medium to high	. . .
VII	Brackish pool	27.0	2.0 to 8.0	Medium	0.1 to 1

SOURCE: Cheney et al. 1977.